Biological basis of behavior

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Objectives

- Name and describe the functions of the three main parts of the neuron.
- Describe the roles played by some specialized neurotransmitters (acetylcholine, GABA, …)
- Describe the structure of the nervous system
- Describe the three major parts of the brain (hindbrain, midbrain, and forebrain)

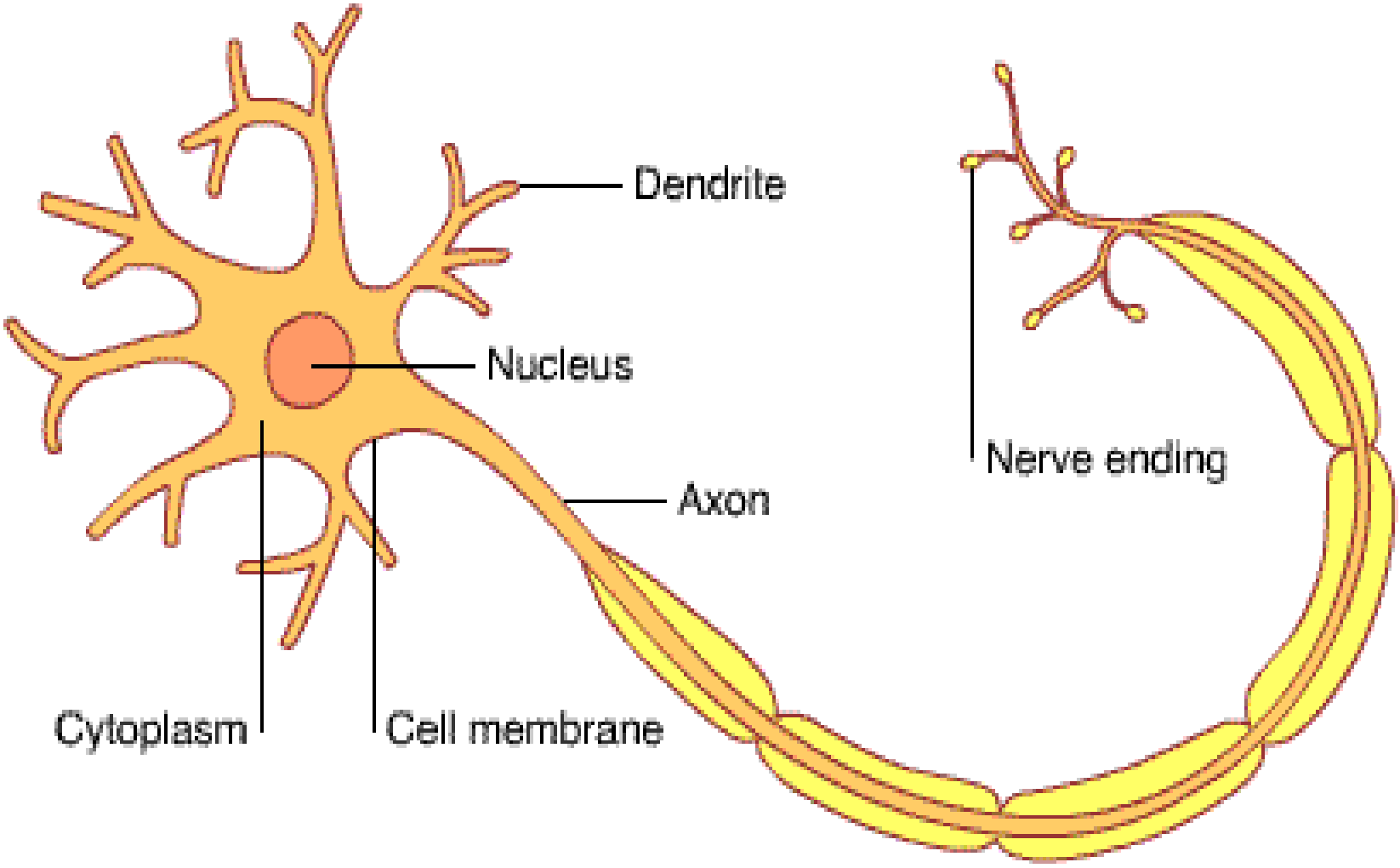
- The physical structure of the body plays an important role in the behavior of an individual.
- The most important physical structure for psychologists is the nervous system.
- The nervous system carries orders from the **brain** and **spinal** cord to various glands and muscles, it also carries signals from stimuli receptors to the spinal cord and brain.

- To understand how the brain controls our experience and behavior, we must first understand how its individual cells function and how they communicate with one another

Neurons

- **Neurons** *are the basic building blocks of the nervous system.*
- Neurons are cells specialized for communicating information.
- They are the basic tissue and element of the nervous system.

- Neurons have a basic structure of:
  - One cell body
  - One axon
  - One or more dendrites


Dendrite
Nucleus
Axon
Nerve ending
Cytoplasm
Cell membrane

The cell body (or soma)

- It is the end of a neuron, containing the cell nucleus. The soma use nutrients to supply energy for neuronal activity.

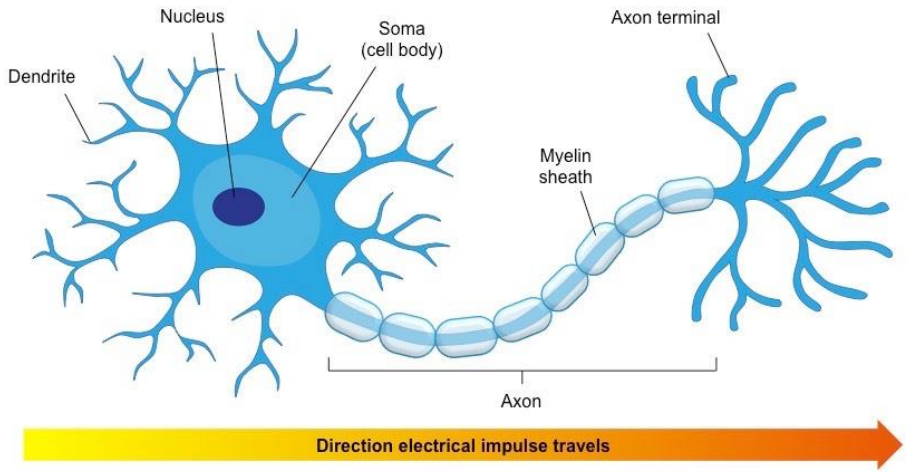
Dendrites

(from the Greek word meaning “tree”)

- Dendrites are branchlike fibers emerging from the cell body.
- They sense the neurotransmitter secreted by the axons of neighboring neurons.
- The many branches of the dendrites can receive input from 1,000 or more neighboring neurons.

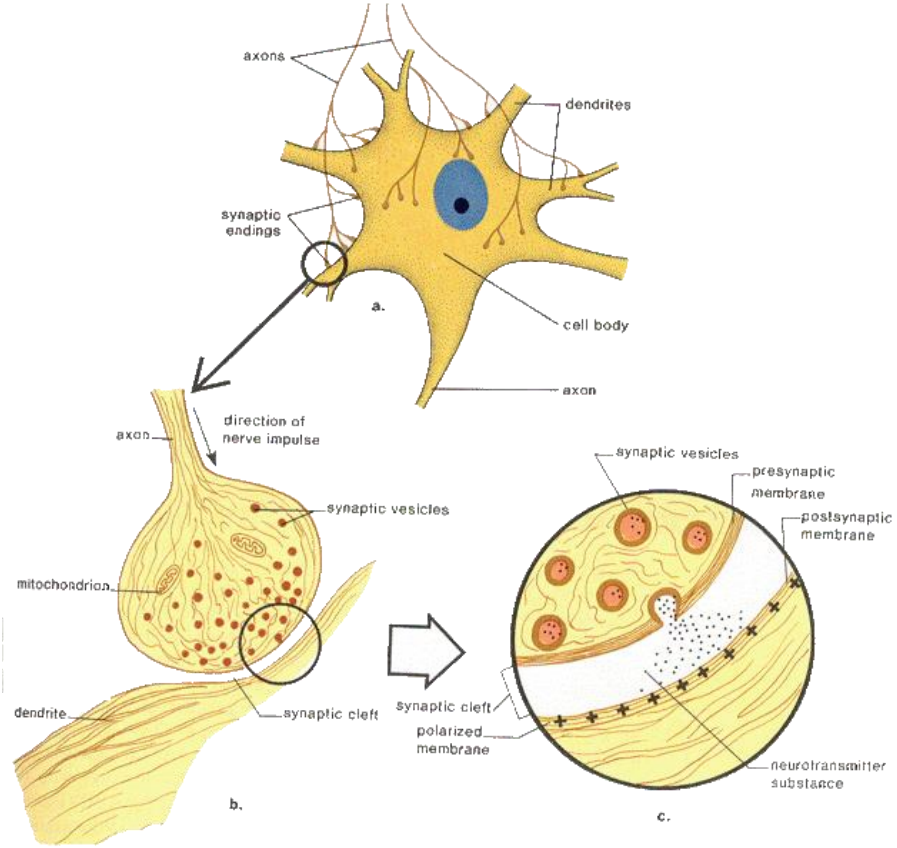
Axon

- Each neuron has only **one** axon.
- The axon branches out at its end to form a number of ***axon terminals***.
- *Axon* conducts ***electrical impulses*** *away from the cell body to axon terminals.*
- The signal travels along the axon in a form of an electrical wave called ac**tion-potential**.



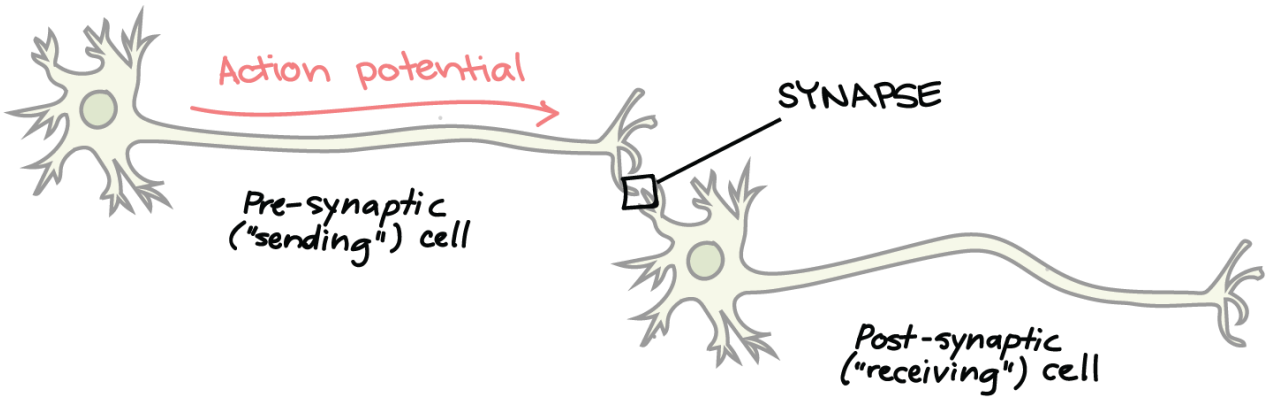
The synapse

- Dendrites and axons do not directly touch each other; there is a **gap**, called **synapses**.
- Synapse are one way junctions between neurons and other cells.
- The neurotransmitter is emitted from the axon of one cell and usually goes to the dendrite of the next cell.



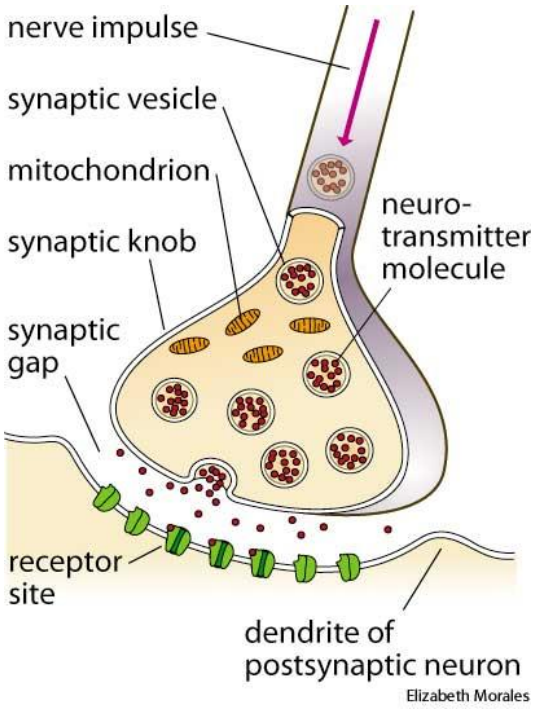
The synapse

- The neuron conducting an action potential toward the synapse is called the **presynaptic neuron**.
- The neuron receiving the signal is called the postsynaptic neuron.



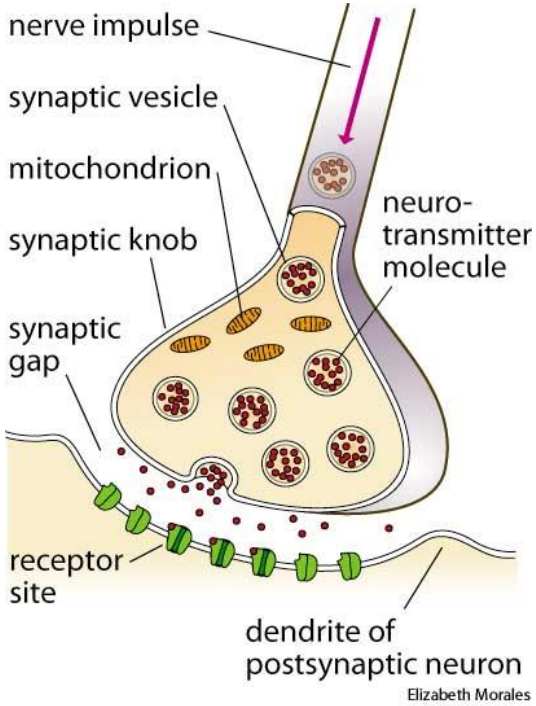
Neurotransmitters

- Electrical current cannot flow directly from one neuron to the other.
- **Neurotransmitters** are chemicals *substances* that are used to *carry messages across the synaptic space to other neurons, muscles, or glands.*



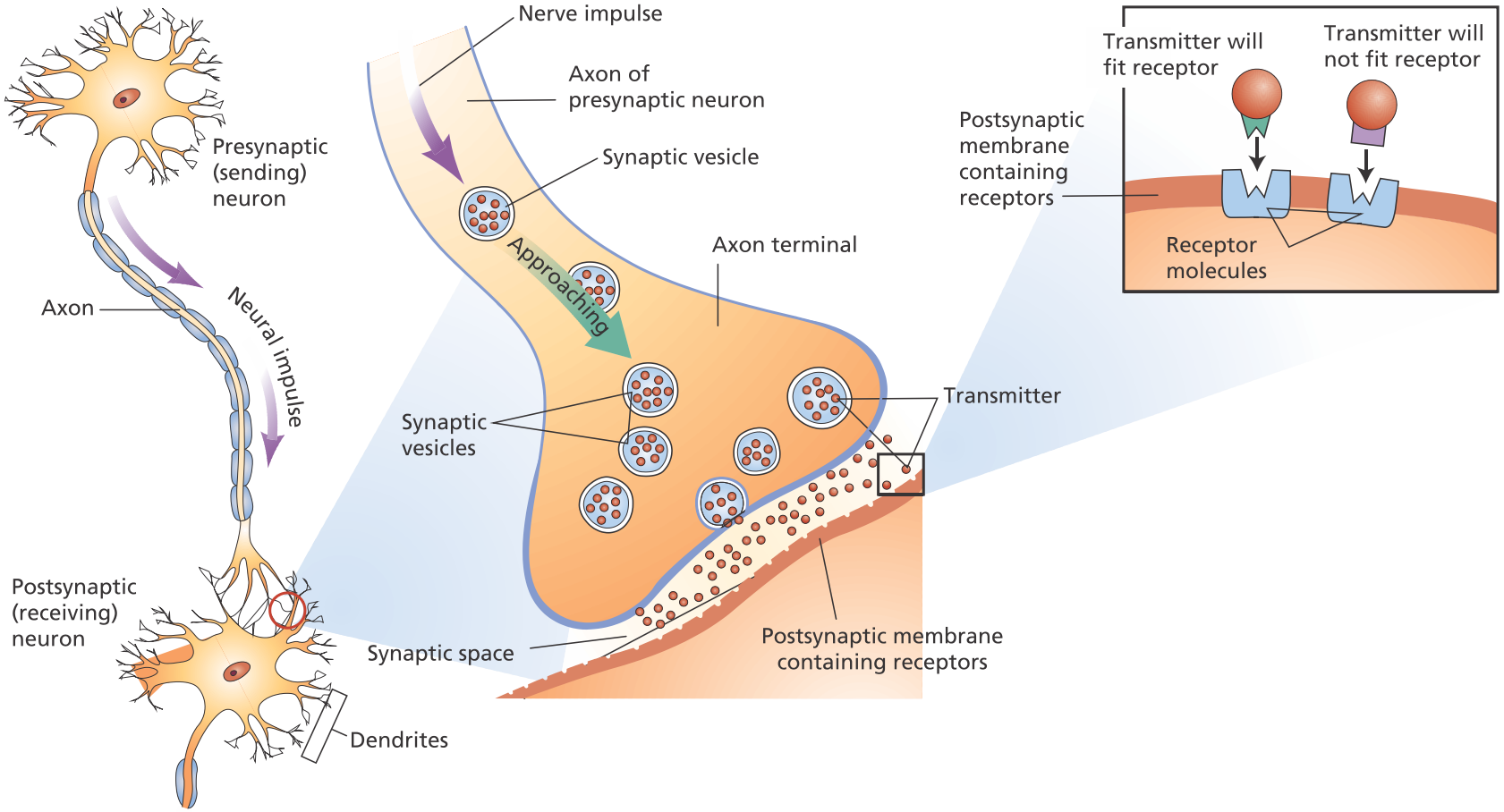
Neurotransmitter

- The Neurotransmitter molecules are *stored* in **synaptic vesicles,** *within the axon terminals.*



Neurotransmitters

- When an electrical signal reaches the end of the axon, the neurotransmitters are **released** from synaptic vesicles into the synaptic space.
- The neurotransmitters molecules cross the synaptic space and ***bind*** to **receptors** *embedded in the receiving neuron's cell membrane.*


Presynaptic (sending) neuron
Axon
Neural impulse
Postsynaptic (receiving) neuron
Dendrites
Nerve impulse
Axon of presynaptic neuron
Synaptic vesicle
Approaching
Axon terminal
Synaptic vesicles
Transmitter
Synaptic space
Postsynaptic membrane containing receptors
Postsynaptic membrane containing receptors
Transmitter will fit receptor
Transmitter will not fit receptor
Receptor molecules

Excitatory vs Inhibitory

Binding of a transmitter molecule to a receptor site, can have two different effects on the receiving neuron:

- ***Excitatory*** transmitter causes the postsynaptic neuron's to fire a signal (action potential).
- ***Inhibitory*** transmitter will do the opposite, making it harder to fire a signal from the postsynaptic neuron even if it receive an excitatory stimulation from other neurons.

Some neurotransmitters that have been linked to psychological phenomena.

Dopamine	Excitatory; is involved in motivation and emotion.	Overactivity → **schizophrenia**
Serotonin	Involved in mood, sleep, eating.	Undersupply → **Depression**; sleeping and eating disorders;
GABA (gamma aminobutyric acid)	The major inhibitory neurotransmitter in the brain.	Destruction of GABA-producing neurons in **Huntington's** disease produces tremors and loss of motor control, as well as personality changes

Some neurotransmitters that have been linked to psychological phenomena.

Acetylcholine	Excitatory at synapses involved in muscular movement and memory	• Memory loss in Alzheimer's disease (undersupply); • paralysies (absence);
Endorphins	• Neurotransmitters released by vigorous exercise, • They are the body's natural pain relievers • Inhibit transmission of pain impulses	

Organization of the nervous system

*The neurons can all be placed in one of two systems :

A. central nervous system

B. peripheral nervous system.

2.The peripheral nervous system

- The peripheral nervous system contains all the neural structures that lie outside of the brain and spinal cord.
- The nerves in the peripheral nervous system are divided into:
  - A. Somatic system connect the central nervous system to sensory organs (such as the eye and ear) and muscles, while the
  - B. The autonomic nervous **system** (ANS) regulates the functions of our internal organs (the viscera) such as the heart, stomach and intestines.

2.The peripheral nervous system

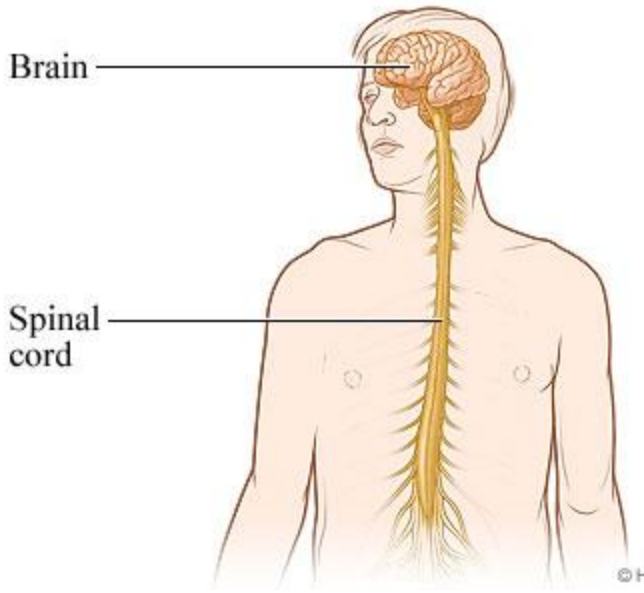
The **somatic nervous system** consists of :

- Sensory neurons that are specialized to transmit messages from the eyes, ears, and other sensory receptors, and
- motor neurons that send messages from the brain and spinal cord to the muscles that control voluntary movements.

- The autonomic system is largely concerned with involuntary functions, such as respiration, circulation, and digestion.
- It consists of two subdivisions, the ***sympathetic*** *nervous system* and the ***parasympathetic*** *nervous system*

The Central nervous system

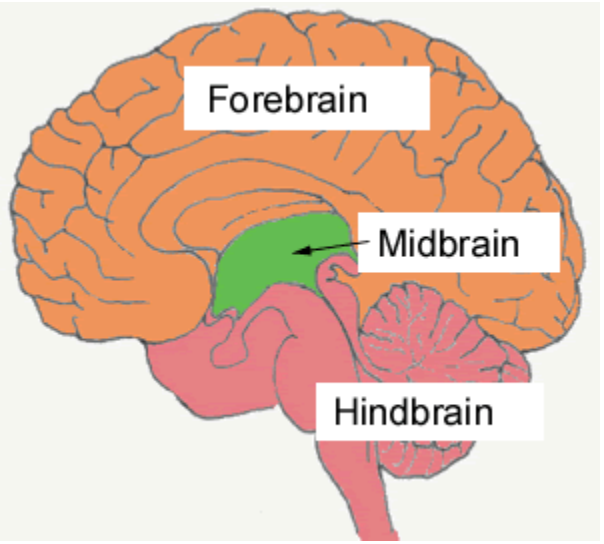
- The central nervous system has a main role in the control of behavior.
- It contains
  1. brain and
  2. the spinal cord
- Both the brain and spinal cord receive signals from the afferent neurons and send signals to muscles and glands through efferent neurons.



Structure and function of the brain

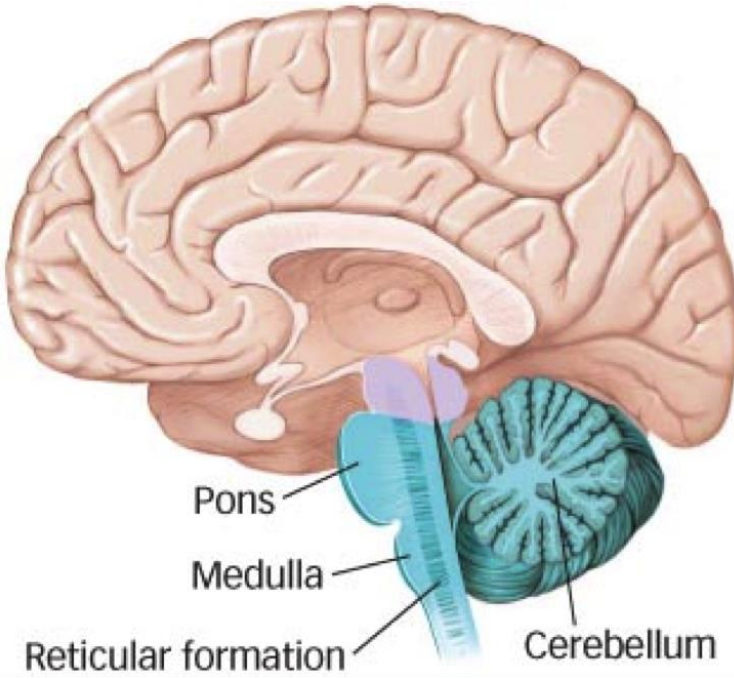
The brain is split up into three major layers,

- the hindbrain.
- the midbrain.
- the forebrain.



1. Hindbrain

- Include medulla, pons and cerebellum.
- **medulla** *plays an important role in vital body functions such as heart rate and respiration*.
- The pons is Involved controlling in sleep and arousal.
- The **cerebellum** *is concerned primarily with muscular movement coordination*



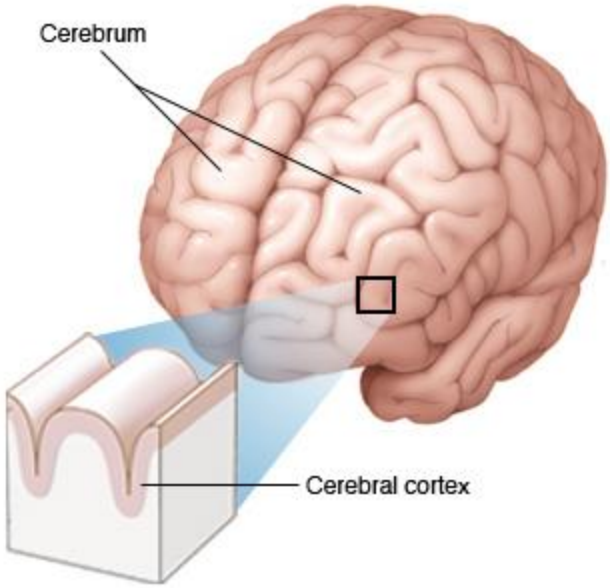
2.Midbrain

- Located between the forebrain and the hindbrain.
- All sensory and motor information going to and from the fore brain and the spinal cord must pass through the midbrain

3.Forebrain

Contains the most complex neural network in the CNS.

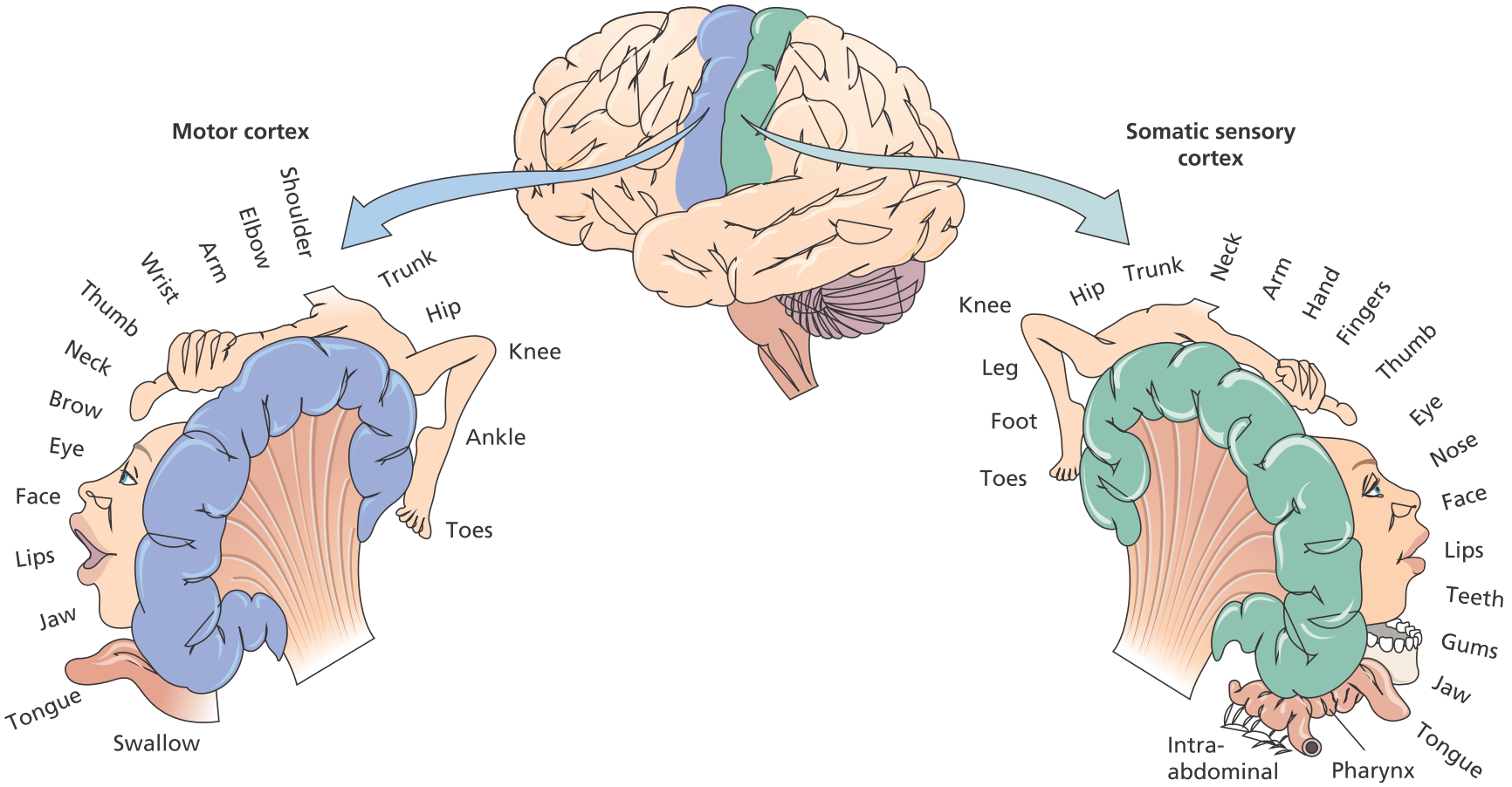
- The cerebrum is the largest and uppermost portion of the of the brain consists of two **hemispheres**, left and right, separated by a fissure.
- The cerebral hemispheres consist of an inner core of myelinated nerve fibres, the **white matter**, and an outer **cortex** of **gray matter**.



Sensory and motor cortex

- The **somatic sensory cortex** receives sensory input that gives rise to our sensations of heat, touch, and cold.
- The **motor cortex** controls the 600 or more muscles involved in voluntary body movements.
- each hemisphere controls movement on the opposite side of the body.

Sensory and motor cortex



Methods for observing or evaluating brain activity

In the past only two methods of observation were available.

- The first was observing individuals who have received brain damage and assume that the part of the brain that was damaged controlled the behavior or sense that had changed.
- The second was connecting **electrodes** to the outside of someone's head and recording the readings.

Newer methods include computed tomography (CT scan) , magnetic resonance imaging (MRI) and others.

Quizzes

1. The neuron conducting an action potential toward the synapse is called the _____

A. Presynaptic neuron
B. Exciting neuron
C. Postsynaptic neuron
D. Input neuron
E. Output neuron

2. Neurons communicate with other cells at junctions called _____.

A. neurotransmitters
B. synapses
C. autonomic nervous system
D. axon
E. denderite

3. Electrical current cannot flow directly from one neuron to the other. A chemical, called a _____, is released from the sending axon and carries the signal to the next neuron.

A. synapse
B. ion
C. neurotransmitter
D. hormone

4. The neuron receiving the signal at the synapse is called the _____

A. Presynaptic neuron
B. Exciting neuron
C. Postsynaptic neuron
D. Input neuron
E. Output neuron

5. Schizophrenia have been linked to overactivity of _____

A. Dopamine
B. Serotonin
C. GABA
D. Acetylcholine

6. Memory loss in Alzheimer's disease has been linked to undersupply of _____

A. Presynaptic neuron
B. Exciting neuron
C. Postsynaptic neuron
D. Input neuron
E. Output neuron

7. The neurotransmitter that Inhibits transmission of pain impulses is _____

A. Acetylcholine
B. Endorphins
C. Serotonin
D. Dopamine

8. The part of the brain concerned with muscular movement coordination is:

- Medulla
- Cerebellum
- Mid brain

9. The peripheral nervous system consists of:

A. Somatic and autonomic nervous system
B. Sympathetic and parasympathetic nervous system
C. Mid brain, forebrain and hind brain
D. Brain and spinal cord

10. The central nervous system consists of:

A. Somatic and autonomic nervous system
B. Sympathetic and parasympathetic nervous system
C. Mid brain, forebrain and hind brain
D. Brain and spinal cord

11. The autonomic nervous system consists of

_____

A. Presynaptic neuron
B. Exciting neuron
C. Postsynaptic neuron
D. Input neuron
E. Output neuron

12. The part of the nervous system that controls the functions of our internal organs (the viscera) such as the heart, stomach and intestines is the

_____

A. Autonomic nervous system
B. Somatic nervous system
C. Sympathetic nervous system